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(6)	THE 2 ND ANNUAL SCIENTIFIC MEETING OF THE EUROPEAN UNDERSEA BIOMEDICAL SOCIETY (5+1)	
(10)	ROBERT GOAD, LCDR, MC, USN*	5-3 July 1979 Lerjen, Norway
(11)	31 DECEMBER 1979	

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UNITED STATES OF AMERICA

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER C-7-79 /	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) THE 5th ANNUAL SCIENTIFIC MEETING OF THE EUROPEAN UNDERSEA BIOMEDICAL SOCIETY		5. TYPE OF REPORT & PERIOD COVERED
7. AUTHOR(s) R.F. GOAD		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS ONR London, Box 39 FPO NY 09510		8. CONTRACT OR GRANT NUMBER(s)
11. CONTROLLING OFFICE NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE 31 December 1979
		13. NUMBER OF PAGES 14
		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) DIVING MEDICINE HYPERBARIC RESEARCH NORTH SEA DIVING SATURATION DIVING DIVING SAFETY DECOMPRESSION		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The 5th Annual Scientific Meeting of the European Undersea Biomedical Society was held in Bergen, Norway on the 5th and 6th of July, 1979. The program included a tour of the recently opened Norwegian Underwater Institute (NUI). Twenty-nine presentations covered a wide variety of topics, focusing to a large extent on current research in Scandinavia, but also including a number of papers from the USA, France, and Great Britain. (continued on back)		

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Included are brief summaries of all the papers and a short note on the annual EUBS business meeting.

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EUROPEAN UNDERSEA BIOMEDICAL SOCIETY
5TH ANNUAL SCIENTIFIC MEETING

The 900-year old city of Bergen, one of Norway's oldest and most important towns, was the host for the 5th Annual Scientific Meeting of the European Undersea Biomedical Society (EUBS) on 5 and 6 July 1979. Participants arriving the day before the meeting opened were treated to a reception at the Bergen Maritime Museum that evening. This setting in the city of a quarter of a million people that was once the northernmost outpost of the Hanseatic merchants (whose wooden warehouses are still maintained on the waterfront of the large, sheltered harbor) was most appropriate, as Bergen, huddled on a peninsula with its homes climbing the sides of the steep mountains surrounding it, is a city which is both welded to and a product of the sea. Fishing and shipping have been the basis of life there for centuries. Bergen is also a gateway city of Norway's famous fjords and to the mountainous country of the Norwegian composer, Edward Grieg, a fact that some attendees were able to take advantage of by joining one of the several post-meeting tours that were offered.

The program committee consisted of Surgeon Captain Jens Smith-Sivertsen and Surgeon Commander Svein Edisvik (both of the Royal Navy) as well as Dr. Jens Grimstad (Haukeland Sykehys) and Mr. Oystein Martinsen [Director of the newly formed Norwegian Underwater Institute (NUI) in Bergen]. Over 130 participants were registered, which continues the upward attendance occurring over the time these meetings have been held.

The Meeting itself was held in the Christien Michelsens Institute. The particular building was very modern and only a year old, although the Institute itself, devoted to research in many areas of technology and social science, was founded in 1930. With the recognition that advances in underwater technology will play a key role in Norway's future, the Institute is hopeful of increasing collaboration with NUI and other underwater research establishments. Dr. David Elliott (Shell, UK) opened the meeting, since Dr. X. Fructus, President of EUBS, unfortunately had a slight mishap on arrival in Norway and following initial treatment in a local hospital, returned to France for further care of what was understood to be a broken ankle. Following the opening of the meeting, a welcoming address was given by Dr. E. Eilertsen, Mayor of the city of Bergen and himself a physician specializing in lung diseases.

There were a total of 29 presentations divided into 6 main sessions, with limited time for open discussion from the floor following the 5 main scientific sessions. There was a mixture of interesting and "ho-hum" papers, but in general standards were good and the meeting was valuable (though it is difficult to forgive one comment which went something like "I won't say any more about this slide since it's self explanatory" as the speaker flashed an incomprehensible spider web of a diagram onto the screen). Abstracts of the papers are to be published sometime in the autumn.

The two lead-off papers by Mr. R. Winsnes (Labour Inspectorate, Oslo, Norway) and Dr. A. Muren (National Defence Research Institute, Stockholm, Sweden) in the first session entitled "Preventive Aspects in Diving Medicine," outlined, respectively, Norwegian and Swedish diving safety philosophies. In spite of the fact that the Christien Michelsens Institute was founded on a donation from the Norwegian Prime Minister who was responsible for the "divorce" of Norway and Sweden in 1935, there were no great differences between the two countries on this issue (in fact the differences of opinion between the UK and Norway on the question of hyperbaric escape and rescue are greater than the apparently minor differences in equipment, devices and regulations between Norway and Sweden). While a Swedish-Norwegian exchange is underway, Muren did comment on the dangers of becoming over-regulated simply by lumping both countries' regulations into one package; rather the best parts of each should be carefully chosen. Winsnes pointed out that Norwegian divers are not union members although the diving companies in Norway do belong to unions. Training facilities in Norway are regulated. Safety delegates are elected by the personnel on the worksite, a fact which led to some concern as to the means of assuring their competence for that task. Muren said that while diving will never be absolutely safe, it could be made safer than at present, but not necessarily by immediately instigating new and rigorous safety measures following an accident. Such measures are not only expensive and time-consuming, but often have negative effects that may not be considered, such as (a) undue complication of erstwhile simple procedures, (b) imposing restrictions on the diver which hinder him from helping himself in an emergency (he added that divers tend to trust and use their own experience and judgement in critical situations to a greater extent than other types of workers), (c) undue confidence in safety devices, and (d) a plethora of inappropriate and ill-thought-out measures which may lead to a disregard of those safety measures that are worthwhile. In his opinion, the most effective method of preventing complications is prior training wherever possible, backed up by information and experience. Stressing the need for a reasonable balance between optimization of protection and minimization of the aforementioned negative effects, Muren outlined the various levels at which safety measures can be introduced:

Selection - noted that special psychological testing is not used in Sweden.

Medical Examination - mainly centers on exclusion of obvious risks although there is a growing emphasis on health per se (i.e., physical fitness, habituation, etc).

Education and Training - the most important level.

Regulations - the most difficult level and obviously the one covering all other levels. Some regulations are felt to be too rigid while other areas are admittedly greatly in need of better regulation but, irregardless, all proposals should be thoroughly studied before they are permanently made law. There is no denial that increasing complexity of diving operations will need increased complexity of the regulations, but reason must prevail.

Equipment, Methods, Safety Supervision, Emergency Procedures, Accident Statistics - evaluation of safety measures would be greatly aided by a better system for quick and selective information exchange (multi-national but on a smaller scale than the International Decompression Data Bank, for example). There is also a need for prompt feedback to the working divers and supervisors since these men cannot learn everything from their own experience. There were several interesting comments from the floor on these first two papers. It was noted that despite Norwegian water temperatures, an anti-freeze device is not automatically delivered with demand valves, but must be ordered separately, a fact which not all divers and contractors are aware of. D. Youngblood (Oceaneering International, USA) said that a data file on "near misses" is not available but it could be as important as fatal accident statistics. He felt that many hazardous operational circumstances would not be identified and improved until there was some system of non-punitive confidential reporting to an impartial body by the divers themselves. As an illustration he pointed out that NASA still uses non-punitive reporting procedures whereas the FAA did away with them sometime last year. Since then, NASA has had three times as many near collisions reported to them than as the FAA, even though both organizations are reporting on the same population. Elliott mentioned that before we begin to put "black boxes" on divers, even one that collects something as simple as depth and time data, an authority has to be identified who has the funds, personnel, and techniques to evaluate this large amount of data,—not an easy task.

The next paper, concerning hyperbaric evacuation, was given by P. Rosengren [Norwegian Petroleum Directorate (NPD)]. In pointing out that safety offshore is the responsibility of the licensee, he said that NPD regulations have taken the approach of telling what should be achieved, but not necessarily how it must be done (i.e., NPD regulations say that there should be some means of evacuating divers under pressure so their chances of escape are the same as other rig crew members but the means of implementing this is up to the licensee). Four main areas were dealt with in this paper.

Transfer into a rescue device - the diving contingency plan must include all necessary details such as: at what depth (usually as close to the surface as possible) should transfer take place; at what depth

in various decompression profiles can divers come directly to the surface; what are the transfer procedures when divers are decompressing or stored at different depths; what should the gas mixture in the hyperbaric rescue device be; how long can men survive in the device under the worst conditions; how are injured divers to be transferred into the device (i.e., if there is a long trunking between the device and the living chamber?).

Launching - the device should not be dependent on ship's power but should float off if ship/rig sinks. If decision is to launch, it must be done at the last moment and reliable communications are important as the captain must give the order. Following a launch, the device (which must be protected from fire) has to be gotten away quickly, either under tow or self propulsion.

Transport and survival at sea - what should the minimally designed survival time of a device be? This depends on where the work is being done which dictates how long it will be before help can arrive. Design criteria in this respect will be different for a device used in the Ekofisk field vice one for the Barents Sea. Survival considerations have to include: enough energy to maintain survivors' body temperatures (heat reflective suits are not efficient in heliox environments, and seasickness often prevents the re-breathing of warm inhaled gas or breathing of different mixes); amount of oxygen to be carried depending on designed survival times; analyzers necessary to keep partial pressures within safe limits; planned energy to run carbon dioxide scrubbers and sufficient absorbent material carried (again re-breathers are not to be relied upon); water and food supply.

Pickup - rescue device must be protected in case of heavy seas and the occupants must also be individually protected (padding, safety harnesses, etc); the device should be a highly visible color and carry a safety flasher beacon; decompression is not normally begun before pickup is made and rescuees have been treated for dehydration, seasickness, shock, etc; reliable communications for two-way communication between rescuees and outside personnel are necessary; the fewer the number of tasks required by the rescuees (who may be very ill) the better; the operation is not over after the pickup—a detailed plan is still needed to know when to start decompression (i.e., should device be taken aboard a ship with chambers or to a shore facility?); standard mating systems for all bells and chamber systems are needed.

Many different rescue devices and systems are now available. Some still need further testing for life support duration, etc. Most of the previous considerations also apply to helicopter evacuation which has the advantage of keeping rescue time to a minimum and getting the survivors to the best shore facilities. No helicopters in current use can lift the present hyperbaric rescue boats; larger payload helicopters in the near future should make rescue planning easier.

This paper elicited a number of comments (both pro and con) on the issue of whether the efforts in this area are reasonable from the point of view of risk analysis and the generally accepted risks in other occupational situations. Though the risk is very low (only one case of hyperbaric evacuation is on record and, in retrospect, it was said to be unnecessary) there is still a great deal of controversy over what is "reasonable." The comment was made that every commercial airline passenger is not required to have an ejection seat, parachute, and survival suit, but in view of events of the past few months, perhaps that statement might elicit an opposite response from what was intended.

B. Vedeler (Det Norske Veritas, Oslo, Norway) gave a presentation on ongoing research in Norway. There was little interest in supporting deep diving research in Norway prior to 1969, when potential oil supplies were discovered on the Norwegian continental shelf. Until recently all deep diving techniques have been directly imported from the USA and France. The NUI, which is Norway's major center of diving research, was not approved until 1975, although Det Norske Veritas had proposed it several years earlier. Three main government organizations sponsor research in this area now: The Royal Norwegian Council of Scientific and Industrial Research, The Council of General Scientific Research, and the Council of Agricultural Research. A number of private institutions and companies also sponsor research. Two years ago the Norwegian Government decided to increase funding for research related to improving safety offshore. Twenty million kroner (around \$3½ million) per year was granted, to run for a 5-year period. The research is concentrated in Bergen at NUI where work is done in close cooperation with Det Norske Veritas Research Group as well as with the University of Bergen Physiology Department and in Haakonvern at the Royal Norwegian Naval Diving School. At present there are 27 projects funded by a little over \$1 million. There projects are in the following categories: Long Term Effects of Diving; Physical Workload and Tolerance in Diving; Compression and Decompression; Communication and Monitoring; Chamber Environment; Diving Equipment; Information Systems Relating to Diving Exposures; Technology of Underwater Operations.

In Norway, the US Navy air decompression tables have generally been the only tables used for air diving. Captain A. Arntzen (Royal Norwegian Navy, Bergen) described an ongoing attempt to increase the safety of these tables in cold offshore work by collecting and analysing the data of 3 Norwegian diving companies who have made thousands of dives on the USN Sur-D-oxygen tables over the past 6 years, albeit introducing modifications little-by-little based on experience. Allegedly these "modified" tables have drastically reduced the incidence of decompression diving sickness (DCS). So far the work has only progressed with surface decompression tables using oxygen, although the intent is to analyse also the experience with standard air tables, repetitive dive procedures and treatment tables. A number of modifications of the Sur-D-oxygen tables based on commercial experience, are felt to be potentially valuable, such as: slower rate of ascent, at least a 2-min. 9-m water stop for dives previously

requiring no water stop, a longer bottom time (t_m) in the model, leaving tissue half times and "M" values unchanged (i.e., $t_m = t_b + t_b/100 (H-20)$ where t_b = bottom time given in USN table and H = depth from USN table in meters. Additionally, giving an "alternative oxygen time" 25% longer than that called for in the tables under conditions of hard work, cold dives, heavy seas, etc., and extending the surface interval to not less than 18 hours between dives (not less than 36 hours between dives if 3 or more dives in a row are undertaken) may make the tables safer yet still operationally acceptable. I will add that these modifications are only suggested possibilities based on a review of a large number of commercial dives and corresponding rates of DCS; certainly they are quite empirical and scientific validation is needed. While the value of experience cannot be denied, it appears that it will be most difficult to say what is beneficial and what is not, if so many variables are altered at the same time. It might be worthwhile to further scrutinize company records to determine the change in bends rate after each modification rather than compare the rates after several years when all the modifications had been made. I do think that the cooperation among the Navy, the Labour Directorate, NUI, and the commercial companies is admirable and gives access to a large amount of heretofore unobtainable data, which is something we have all wanted to see for years.

J.M. Calder (Institute of Pathology, London) showed a sampling of pathological slides from a series of 66 cases of fatal U/W accidents, with emphasis on the many that could have been completely avoided if only regulations currently in force had been adhered to (the majority of the fatalities occurred in areas of the world where no such regulations exist). Following this, R.E. Peterson (NUI), described preliminary results from a research program designed to determine the work capacity of divers using underwater breathing equipment, to investigate factors limiting exercise in diving. The methodology is still under development for this project; one interesting finding that has already been seen, however, is that using a low resistance breathing apparatus, as the diver approaches exhaustion his breathing rate, tidal volume, and ventilation all rise (as expected), but as the diver approaches exhaustion using a standard type UBA, breathing rate increases while both tidal volume and ventilation fall. This inappropriate ventilatory response to exhaustive breathing with resistive underwater breathing equipment may be responsible for subjective feelings of impending loss of consciousness in this and previous studies. Further work is underway, including blood gas analysis.

Martinsen gave us as a tour of NUI an introduction to the Institute prior to the last event of this first day. A pilot project at Det Norske Veritas since 1971, the non-profit Institute was founded in 1976. It is owned (50% each) by Det Norske Veritas and the Royal Norwegian Council for Scientific and Industrial Research. Activities include testing of U/W equipment, R&D in submarine technology and hyperbaric physiology, consulting in the field, improving field training facilities, and establishing facilities for hyperbaric medical treatment. The main building at Hestviken (Horse Bay) was completed in late 1977 on land leased by the Royal Norwegian Navy (for one krone per year) and the hyperbaric chamber was completed in January 1979. The location was chosen to take a

of the deep fjords for testing purposes and of Bergen's proximity to major North Sea activities. Six million dollars to date have been invested in NUI, half in buildings and half in laboratory facilities. A testing and training center for subsea production is in the planning stages and the Norwegian State Diving School will be a next door neighbor in 1980 or 81 (interim courses will commence in October of 1979). Horse Bay is a deep water bay and the quay at the Institute can take alongside any North Sea diving vessel. The front parking lot has been marked as an emergency landing space for helicopters. The hyperbaric chamber complex, core of the facility, consists of 4 interconnected chambers. Two are living chambers (max. depth 500 msw) accommodating a total of 8 divers. The third is a transfer lock with sanitary facilities and the fourth is a large (3-meter diam. and 7.2-meter length) wet/dry work chamber (max depth 650 msw). The end of the work chamber can be lifted off on hydraulic rams, giving access to the whole 3-meter cross-section and up to 30 tons of equipment can be rolled into the chamber on rails. There is also a separate chamber for equipment trails and animal work (rated at 3000 msw). One feature I found particularly appealing was that all chambers are connected to the various life support equipment via ducts in the deck, and so the space around and above the chambers is completely clear for experimental setups. There is also a large pool (5 x 7 meters by 3.5 meters deep) in the main building, and water temperature there (as well as in the workchamber when it is used in the diving bell/water environmental mode) can be maintained anywhere between -1°C and +32°C.

NUI's staff consists of 35 people, aiming for 40 by the end of this year. Half of them have Master's degrees or higher. NUI's tasking is 3 main areas:

1. R&D (hyperbaric medicine and physiology, U/W operations methods and U/W technology).
2. Information and Training (distribution of newsletters and reports, literature searches, U/W literature library, organization of specialized courses).
3. Commissions from Industry. Several examples of current contracts were given. This area provides about 35% of NUI's income, aiming for 45% in the future.

In general, after a tour of the facility and a look at some of the ongoing projects, one could not help being impressed by the efforts being made by Norway and NUI to catch up and, in fact, forge ahead in this area, notwithstanding a very recent start.

Following the first day of the meeting, most of us attended the not-to-be-missed banquet at Haakonshallen (King Haakon's Hall) where we were treated to trays heaped with Norwegian delicacies such as buried salmon, reindeer steaks, and "cloud berries" (a particularly tasty fruit, found only high in the mountains, and served with whipped cream). Haakonshallen

itself was a magnificent setting. Built between 1247 and 1261 as a Royal Ceremonial Hall, it was badly damaged by an explosion and fire in 1944, but luckily for us, restored from 1957-1961. After the meal Norwegian dancers (one of whom was Dr. Jens Grimstad) performed some traditional dances for us, Norwegian folk dancing can be a dangerous occupation if you are not born to it, as my wife found out later in the evening. She was still limping from a sprained ankle a week later.

The second day of the meeting opened with a 5-paper session on "Decompression". B.G. D'Aoust (Virginia Mason Research Center, Seattle) described his groups' work using an animal model to examine the "minimal delta P's" that lead to intravenous bubbling (a Doppler-implanted goat that is saturated on nitrox and then isobarically shifted to heliox—since there is no change in ambient pressure, they can study the results of supersaturation alone without the added problems of decompression). The main points were that results in their laboratory (i.e., extremely long term bubbling after such a switch) are consistent with both "expandable" and "renewable" bubble formation sites or nuclei, and that the levels of supersaturation which cause a great deal of bubbling are evidently a lot lower than the levels we now accept in formulating decompression tables. J. Grizelin (Comex, Marseille, France) read a paper which added further positive results to the observations made last year at Luxembourg; i.e., that in a series of heliox bounce dives, they can establish a correlation between bends and circulating venous gas emboli (vge) after movement and that, for a given bubble grade, these vge are less dangerous during bounce dives decompressions than during saturation dive compressions.

Preoxygenation has been used as a method to decrease the risk of DCS during flying at high altitude without cabin pressurization. The purpose of the next study presented by U. Balldin (Karolinska Institute, Stockholm, Sweden) was to see if preoxygenation could also be used to prevent DCS when diving was followed by flying with maximal cabin altitudes of fighter aircraft. Though the appearance of intracardial bubbles and symptoms were said to be less and their onset later with 1 hour of preoxygenation before flying (that had been preceded within 12 hours by diving to 39 meters for 10 min. or 15 meters for 100 min.), the differences were not statistically significant and the numbers involved ($n = 6$) were small. At the moment then, there is insufficient evidence to recommend this procedure as a safe method to avoid DCS. There were no plans to look at preoxygenation done immediately after the diving, but this was raised from the floor as an interesting possibility.

J.R. Høifodt (NUI, Bergen, Norway) reported on attempts to measure tissue impedance in rats during simulated dives as a method to detect bubble formation. Conclusions were that such changes are a function of initial and final pressures as well as the way in which the pressure is changed (the decompression profile). Further work with unanaesthetised animals was planned. It was suggested from the floor that dead animals should be run using the technique to obtain a more well-defined baseline.

The final paper in this session was by A.C. Palmer (Department of Veterinary Medicine, Cambridge) who described the neuropathology of lesions in a series of experimentally decompressed goats, as shown by both light and electron microscopy. CNS lesions, confined to the spinal cord, occurred in 28% of the animals showing transient DCS and in 83% showing limb paralysis. Twenty-four to forty-eight hours post decompression early infarction of the white matter was accompanied by edema and microthrombi. Proteinaceous edema also occurred in the gray matter (dorsal horns) although there was generally preservation of the gray matter as well as the marginal myelin. Pathogenesis of both gray and white matter lesions was felt to be probably the same and could be related to vessel occlusion by the formation of microthrombi. As far as I'm aware these are similar to DCS lesions described in other animal models such as dogs and guinea pigs and are more typical of ischemias due to venous drainage blockage than they are of arterial obstruction lesions, which predominantly cause gray matter damage. There are, however, other experimental DCS pathological findings as well as reports of clinical symptoms indicating that both mechanisms may be involved to varying degrees in decompression myelopathies. In addition to prior work by Palmer and colleagues and by Hallenbeck and colleagues, there is a short but pertinent discussion of this subject by Dr. Gaspare Albano in the "Letters to the Editor" section of the June 1976 issue of *Pressure*, the Undersea Medical Society Newsletter (Vol. 5, No. 3).

W.A. Crosbie (North Sea Medical Centre, Great Yarmouth, UK) led off the next session, entitled "Hematology and Circulation" by describing a somewhat confusing (to me) group of hematological, biochemical and hormonal abnormalities in 12 North Sea divers. In particular, I wonder whether the low packed cell volumes (less than 40) and the low hemoglobins (less than 12), which were seen in 2 divers and attributed to hemodilution, might more likely have been caused by an iron deficiency anemia since they were seen at a time (a few minutes post decompression) when, if anything, one would expect hemoconcentration. One finding not further commented upon was the high carboxy hemoglobin levels (mean $8.7\% \pm 2.2\%$) present in the smokers as opposed to the non-smokers (less than 1%). I think it is worth reminding ourselves that in addition to accelerating atherosclerotic changes in blood vessels and increasing vessel permeability, the carbon monoxide that makes up about 4% of the smoke of an average American cigarette has a strong affinity for hemoglobin. A 5% level of carboxy hemoglobin has been shown to impair both vision and judgement. A smoker will have anywhere from 4-15% (as re-affirmed by the mean of 8.7% Crosbie found). Furthermore, it takes a heavy smoker approximately 8 hours to rid his system of 75% of the carbon monoxide he has inhaled. Just another factor modifying any individual reaction to a given decompression profile, but perhaps one that has a greater effect than we might think.

G. Nichols gave the first of several papers coming out of the Admiralty Marine Technology Establishment (AMTE) (Physiological Laboratory, Alverstoke,

(UK). He reported on recent observations of increased erythrocyte sedimentation rates (ESR) that seem to be a fairly consistent finding during the latter stages of decompression from deep heliox saturation dives. It has also been seen, though less consistently, in shallow saturation air dives to 15 meters, but has not been seen in a series of non-saturation air dives to 30 meters. Magnitude of the ESR changes was not related to depth or oxygen partial pressure. A problem very similar to that encountered with the use of ultrasonic detectors is that although all subjects manifesting symptoms of DCS exhibited these increased ESRs there were also subjects with identical changes who had no symptoms of DCS. Another problem mentioned of course, is the non-specificity of the ESR. Next, R.F. Carlyle (AMTE) gave a complementary paper on observations of abnormal red cell production in men subjected to simulated dives to 31, 19 and 43 bar. Such cells may be physiologically involved in decompression pathology and may be early indicators of decompression stress. The spiculed echinocytes seen, seem to be a result of metabolic internal changes (perhaps macromolecular binding of carbonic anhydrase to the cell membrane) rather than mechanical or chemical (changing the external environment) changes. Recently this group has shown that even when obvious morphological changes are not seen, sensitization of some kind frequently occurs; i.e., with very slow decompression, no echinocytes are observed, yet if the normal appearing red cells are stressed, echinogenesis can be induced early in decompression. Furthermore such deformations can be induced by stress (*in vitro* incubation) while still on the bottom, so the phenomenon is not necessarily decompression related—the stage is apparently set before beginning decompression. Further work is planned in relation to both the ESR and the abnormal red cell observations. The possibility exists that these changes may be sensitive indicators of potential problems, especially if they can be linked to the presently rather confusing picture of other known biochemical and hematological changes. It was noted that echinogenesis was more marked when DCS occurred but not enough is yet known to comment on any prognostic value.

J. Onarheim (Univ. of Bergen, Norway) discussed experiments undertaken to study effects of high ambient pressures and oxygen tensions on circulation. Results in anaesthetised rats indicate that high ambient pressures with or without accompanying high oxygen tensions, are associated with increases in cerebral and myocardial blood flow of about 30% without changes in cardiac output. High ambient pressures and/or high oxygen tensions reduced renal blood flow. There was no explanation for the different effects on different organ systems. Further work using heliox in place of nitrox, and using unanaesthetised rats is planned. The last paper of this session, given by J. Pooley (Univ. of Newcastle upon Tyne, UK) was one of the best papers of the meeting. Changes in Xenon-133 clearance from bone marrow and skeletal muscle of rabbits during simulated dives to 15 and 30 meters showed that isotope clearance increased during compression and decreased during decompression (the decrease—occasionally ceasing completely for as long as 5 minutes after decompression—depending upon length and depth of exposure). Rather than isotope

clearance cessation being due to a total cessation of blood flow, it was felt "gas induced osmosis" (for lack of a better term) was a more likely explanation, i.e., during compression, with a transient increase in blood PN_2 , fluid would move across capillaries into the blood, increasing flow and isotope clearance, while the opposite effect would occur during decompression. The hypothesis was tested by changing arterial blood toxicity at atmospheric pressure and results showed that isotope clearance was in fact increased with the intra-arterial introduction of hypertonic saline and reduced (sometimes to zero) with hypotonic saline. This work plus the high lipid solubility of nitrogen helps explain the predilection of osteonecrosis for the fatty marrow of long bones. Later work showed that in long duration dives, (greater than 3 hours) bone marrow isotope clearance began to decrease while the animal was still at pressure, while muscle isotope clearance was unchanged from that seen during the short dives.

The final afternoon of the meeting began with a 4-paper session on "Respiration and Metabolism." By one of those rare coincidences, the first two papers by C.M. Hesser (Karolinska Institute, Stockholm, Sweden) and C. Lundgren (State University of New York at Buffalo, USA) were by investigators who independently have been looking at the same problem and have simultaneously come up with the same answers, using different methods of investigation. In the past, attempts to predict exercise ventilatory capacity at depth from values of maximal voluntary ventilation (MVV) achieved during resting conditions at normal atmospheric pressure have assumed that MVV at increasing depth (1) is inversely related to the square root of the gas density, and (2) is the same in exertion as at rest. Both Hesser, by studying subjects in the dry at work and at rest in raised ambient pressures, and Lundgren, by doing a very similar study in immersed subjects, have independently concluded that these assumptions are incorrect and have come to similar conclusions for the results they obtained. In general, results showed that MVV at rest as ambient pressure increased was higher than would be predicted from the differences in gas density. MVV increased significantly 10-15% during exercise (as compared to MVV at rest) at all pressures studied. Larger expiratory reserve volumes and mid-expiratory volumes during MVV that were observed with increased ambient pressures, plus higher endtidal carbon dioxide tensions, were presumed to have influenced airway resistance and would account for the observed findings.

The next paper by L.A. Wennberg (National Defence Research Institute, Stockholm, Sweden) described a micro-processor attached to diving apparatus which controls measurements of inspired air flow, air temperature, ambient pressure, oxygen fraction of expired air, respiratory rate and heart rate. The goal is to be able to estimate energy expenditure of a working diver and the method is based on a modification of Weir's formula (Wennberg et al., A New Formula for Estimating Metabolic Rate, *Europ. J. Appl. Physiol.* 35, 231-234, 1976). So far the equipment, connected to AGA diving apparatus, has been chamber tested to a depth of 40 meters. The session was finished

with a paper by M.P. Garrard (AMTE) discussing nitrogen metabolism during recent chamber saturation dives to 420 msw. It was proposed that compression, pressure per se, and decompression stimulate a specific pathway of protein catabolism and result in the increased nitrogen excretion that was observed in the four subjects studied. It was also suggested that stimulation of protein catabolism might be elicited by raised serum T₄ levels in the presence of raised plasma noradrenaline levels, both of which were also observed.

The next session on "Osteonecrosis" was a short one, consisting of just 2 presentations. J.A.B. Harrison (Surgeon Rear Admiral, Institute of Naval Medicine, Alverstoke, UK) gave a concise review of the field, including bringing the audience up-to-date on the most recent survey, which looked at 934 non-randomly selected US Navy divers (the incidence of osteonecrosis is very low and may even turn out to be lower than the RN 1.7%). He pointed out that the RN philosophy in this area is also well summarised in the discussion section of the USN survey paper (NSMRL, New London, CT, March 1978). After reviewing the present state of prevalence in relation to three major surveys, present knowledge in relation to suggested management of the lesion was summarised and some of the possible lines of research into etiology of the disease were discussed. Emphasis was placed on the fact that osteonecrosis is a real hazard in divers but the risk is very low. An analysis of the British Medical Research Council records in January 1979 by the British Diving Medical Advisory Committee reported that an ever increasing number of radiographs are becoming more and more serial as time goes on, and this should prove most valuable as the majority of lesions take a long time to develop. In this analysis the percentage of definite joint lesions with no evidence of joint damage was 0.8% and the percentage of definite joint lesions with associated joint damage was 0.1% (4030 records analysed). Admiral Harrison also mentioned several problem areas that still exist. For example, in saturation diving more information is necessary to determine how variables such as age, experience, depth, DCS, etc., influence the incidence of osteonecrosis. Another problem (primarily medicolegal) is what to do with divers who develop a "B" or shaft lesion. There are as yet not enough numbers to establish a connection between "A" and "B" lesions; i.e., are joint lesions more likely to develop once shaft lesions are present? Should diving be stopped? Should it be limited? Everyone now agrees that "A" lesions are always potentially crippling and further exposure should be stopped. Finally, on the issue of isotope scans, it was pointed out that once a lesion appears it can go either way. That is, it can either resolve or progress onto a radiologically detectable lesion. This led into the next paper by G. Nieding (Federal Public Health Office, Berlin, FRG) discussing the results of a recent German investigation which they believe clearly shows that scintigraphy permits earlier diagnosis in most cases of pressure induced osteonecrosis as compared to x-ray diagnosis. He felt that both methods should be used regularly in combination and listed the advantages of scintigraphy as (1) very low radiation burden, (2) permits earlier recognition in most cases and (3)

gives the clinician more information on the activity of the lesion. At the end of these two papers, there were several comments from the floor. The answer to the question of what the progression of a "B" lesion is after a management decision had been made to curtail further exposure to pressure was unknown. R.I. McCallum (Univ. of Newcastle upon Tyne, UK) said that one must remember that a single (bad ?) decompression after a relatively shallow exposure can cause bone damage (cited the HMS *POSEIDON* submarine disaster), and also that there are workers who have been bent many times and have no evidence of bone damage as well as bone damage occurring in men who have never been bent.

The meeting ended with a final session of 5 papers that did not really fit into any of the earlier categories. W. Thoma (Institut für Flugmedizin, Bonn, FRG) described the behaviour of transcutaneously measured oxygen partial pressure during diving (dry chamber) experiments. It was concluded that the transcutaneous method can provide valuable information concerning actual arterial oxygen partial pressure changes under hyperbaric conditions. I am glad he did not go further than that at this time, as there are still significant problems with this method in spite of the obvious advantages if it could be made reliable. A. Chaumont (CERB, Toulon, France) talked about findings of increased turn-over of brain dopamine, noradrenaline and serotonin under high partial pressures of oxygen and possible mechanisms. The role of this hyperoxic increase of neuroamines in the development of oxygen toxicity is not clear. P.A. Hayes (AMTE Physiological Laboratory, UK) reported on changes in perceived temperature sensation during long duration dives to 43 bar. Observed reduction in sensitivity appeared to be related primarily to the time spent in oxy-helium. A change in the central interpretation of the peripheral temperature was suggested. There was no disruption of autonomic thermoregulation.

H.C. Örnham (Univ. of Lund, Sweden) has been looking at the long- and short-term effects of diving on the ear-clearing capacity of divers. In his study a majority of the subjects did not get any measurable change of their ear-clearing capacity over a period of repeated diving, however, as experience was gained, subjects did tend to switch to the Frenzel method of ear clearing, vice the Valsalva method (Frenzel maneuver basically consists of voluntarily closing the nose, mouth and glottis, then using the tongue as a piston to compress the air in the nasopharynx and force it up the Eustachian tubes—difficult to learn supposedly and hard to teach, so this finding of subjects voluntarily switching methods with experience was somewhat unexpected). It was felt that the Frenzel method should be taught in diver training since it has the advantages of not generating high intrathoracic pressures and being less prone to lead to round window rupture. Though actual pressure measurements were made in this study, similar findings have been reported by Riu et al. in 1969 when they found by survey that experienced divers rarely use the Valsalva maneuver. D.J. Harris (AMTE Physiological Laboratory, UK) gave the final

paper of the meeting wherein he discussed "hyperbaric hyperreflexia" and its possible attenuation by nitrogen. Preliminary findings indicate that the addition of nitrogen might effectively reduce or reverse some of the hyperreflexic effects of hyperbaric heliox environments. He pointed out that there is no convincing evidence one way or another that other symptoms of HPNS (i.e., EEG changes, vestibular symptoms, etc.) would be favorably influenced.

For those who have been interested in the progress of the EUBS over the years, there follows a brief report of the annual general meeting that was held on July 5th. Annual dues are to remain at five pounds sterling. Outgoing officers are S. Fructus (President), E. Hansen (Secretary), and R. Cox (Member-at-large). Newly elected officers are D. Elliott (President), T. Nome (Vice-President), N.K.I. McIver (Secretary), and J.N. Norman (3 year Member-at-large). T. Shields will remain Treasurer and Membership Secretary and the two other members-at-large will be H. Ornhagen and R. Hyacinthe. The EUBS has now grown to 213 members. Future planned meetings are as follows:

1980 - to be held in conjunction with the 7th U/W Physiology Symposium 5-10 July in Athens (the EUBS will sponsor the fifth and final day and presentation will be confined to clinical and operational aspects of underwater medicine).

1981 - Churchill College at Cambridge, UK (date to be determined).

1982 - site and date not yet determined but there have already been two offers of sponsorship (Lubeck, Germany and Barcelona, Spain).

Finally a workshop that may be held early in 1980 in Paris is in the planning stages.